

NANCREDE. (G.B.) *al*

RECENT ADVANCES IN THE SURGERY
OF THE BRAIN AND ITS
COVERINGS.

BY

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CHARLES B. NANCREDE, M D.,

SENIOR SURGEON TO THE EPISCOPAL HOSPITAL, SURGEON TO THE JEFFERSON
MEDICAL COLLEGE HOSPITAL, LATE LECTURER ON SURGERY
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MR. PRESIDENT AND FELLOWS OF THE ACADEMY OF SURGERY: In casting about in my mind for a topic worthy of the consideration of this learned body, it occurred to me that an inquiry into the recent advances made in the surgery of the brain and its coverings, might prove both interesting and profitable.

I have endeavored, by repeated eliminations, to prepare a condensed account of all the essential advances made since I completed my monograph upon "Injuries of the Head," which in the delivery shall not exceed the time allotted me by custom; this will necessitate the omission of many interesting details. While repudiating all intention to dogmatise, I shall endeavor to formulate *provisionally* some general rules for our guidance in practice, and on the witness-stand. Some of the alleged advances will, upon examination, resolve themselves

¹ Annual Oration, delivered before the Philadelphia Academy of Surgery, January 3, 1888.

into mere confirmations of much older tentative propositions. Statistics will not be introduced, except when necessary to prove the truth of assertions apparently opposed to previous experience, nor will details and histories of cases be interpolated, except when needful to illustrate a principle or elucidate some obscure point.

It has recently been shown¹ that, while of unusual occurrence, the smallest scalp-wound, if it become infected, may by progression of the septic inflammation lead to periostitis, purulent ostitis, osteophlebitis, encephalitis; or, again, from the periosteum the infective process may, by continuity of tissue, through osteophlebitis, initiate thrombosis of the cerebral sinuses with consequent pyæmia.² Suppose a recent head injury just brought into the hospital, how should we proceed? Do not carelessly pass the forefinger through the filthy, blood-matted hair, and explore at once the depths of the wound, to ascertain its nature, as is too commonly the rule, but carefully shave the scalp, scrub it with nail-brush, soap and water, remove all fatty matter with ether, or a mixture of turpentine and alcohol, completing the disinfection by a thorough irrigation with mercuric bichloride solution. Only now should the wound be examined, when, if either bone or periosteum be found injured, such incisions are indicated as will give free access to the deeper parts, which must next be cleansed. All small, loose fragments of the external table are to be removed; if large, after disinfection, they should be perforated and sutured in place with catgut, leaving sufficient space between the fragments for drainage; all sharp edges should be smoothed off, and, if deemed necessary, catgut drains can be placed between the osseous fragments. Should

¹ W. Wagner: Königshütte, Volkmann's Sammlung klinische Vorträge, Nos. 271, 272, Chirurg., Nos. 85, April 20, 1886.

² Horsley's case, Med. Press and Circular, 1886, N. S., 495.

there be simply a *clean* fissure, let it alone; but if a *soiled* one, cut it out with a chisel and thoroughly disinfect.¹

By the light thrown by experiment, and confirmed by recent experience, we must entirely revise our conclusions as to the dangers of trephining, *per se*, or of converting a simple fracture into a compound one. Roberts's propositions would now meet with general acceptance.² Certainly, our increased knowledge as to the risks of the late cerebral mischief, too often entailed by the erroneous opinion that trephining is only indicated when symptoms of *compression* are present, serves to teach more strongly that which I, in common with Gross, Briggs, Gunn, Roberts, and others, have insisted upon, viz., preventive trephining. Wagner has recently presented a more cogent reason for immediate interference in these words: "The entrance of foreign bodies and injuries from unclean objects, therefore, indicate the use of the trephine," because "it is of far greater importance to prevent the infection of the intracranial tissues, than to relieve the brain from pressure;"³ even a hair caught in a fissure will certainly produce infection if not promptly removed, as has been proved in more than one instance.⁴ The value of what may appear to some, unnecessary precautions, is proved, when we reflect that when immediately put in practice the mortality was only 1.23; whereas, when twenty-four hours or more had elapsed before treatment was instituted, the death-rate was 33.33 per cent.⁵

Special precautions must be observed when both walls of the frontal sinus are broken. Most thorough disinfection of the sinus should precede perforation of its pos-

¹ Hippocratic experience revived, since this was advised by the Father of Medicine, although upon a different theory.

² August and September numbers, *Annals of Surgery*, 1885.

³ W. Wagner, *op. cit.*

⁴ Wagner, *op. cit.*

⁵ Wagner, *op. cit.*

terior wall, and at the conclusion of the operation, the cavity must be carefully tamponed with iodoform gauze, remembering that symptoms of secondary compression may result from swelling of the tampon, by imbibition of wound fluids. The orbital margin should be unhesitatingly resected, if necessary to remove infected materials or foreign bodies.

I would, therefore, lay down the proposition: that in the present state of science, the surgeon who neglects to resort to the foregoing precautions is derelict in his duty.

A triumphant demonstration of the value of attention to details is given by Wagner, all of whose cases of fractured base who survived the first twenty-four to forty-eight hours—23 in number—recovered. Similar results can only be attained by attention to the following precautions, in addition to those already mentioned: The external auditory canal of the ear traversed by the line of fracture, must be most cautiously and effectively disinfected, filled with iodoform, and plugged with antiseptic gauze. If the ethmoid be fractured, iodoform should be dusted or insufflated into the upper part of the nasal cavities. Extensive fractures with alarming nervous symptoms, due to extravasation of blood or inflammatory exudates, do not contraindicate operation in fractures of the vault, or accessible portions of the base; since, if such cases are recoverable at all, this desired end is more likely to be attained by the effective drainage and asepsis secured by operative interference.

Bearing in mind the immediate risks of encephalitis and the future ones of epilepsy and insanity there can be but one opinion as to the advisability of trephining for all varieties of accessible cranial fractures, provided it can be shown that the operation, *per se*, is not a dangerous one. Undoubtedly, under the old regime, the mortality of the operation was 10.69; but is this true with an improved technique? Certainly not; for after eliminating

from Amidon's¹ tables certain cases where no trephining was done, many which were not treated strictly aseptically, verifying the remainder and adding others, Seydel has tabulated 61 cases of operations for epilepsy, neoplasms, etc., which would indicate that strict aseptic methods reduce the mortality of trephining, *per se*, to 1.60 per cent., although it must not be overlooked that injuries to the brain, its membranes or vessels, by careless operating, will increase this death-rate.

If the mortality be so low for operations where no recent injury exists, how much more imperative should it now be to trephine immediately in recent compound and even simple, markedly depressed vault fractures, except in young children.

Are there any new principles deducible from recent experience which should govern the technique of trephining?

At once the question of drainage confronts us: Shall it be capillary or by tube? Upon a nice discrimination of cases will, I believe, depend success in practice.

For trephining in fractures, epilepsy, or insanity, in which no lesion of the dura mater exists, catgut, and catgut only seems indicated.

Where large portions of bone have been removed and replaced in toto, no other method of drainage is possible.

With lesions of the dura mater which are reparable by suture,² the same kind of drain is indicated, except when a brain tumor has been removed.

Wounds of the dura mater which cannot be sutured indicate tube-drainage, or, better, Horsely's method.

¹ Annals of Surgery, March and April, 1885, p. 196, et seq.

² Antiseptic und Trepanation, von K. Seydel, Munich, 1886.

³ Hopkins: Polyclinic, vol. v. No. iv., also many other cases on record. I have myself used this method with advantage.

Trephining done for intracranial abscess calls for the use of the tube very gradually shortened, with the strictest watching of the case for some weeks after final withdrawal.

If the first perforation made does not effectually drain a blood or pus cavity within the membranes or brain, when the patient is in *the recumbent position*, either a second opening at the most dependent point should be made and through-drainage instituted, or, better still in many cases, the first button of bone should be replaced after removing a small segment of its periphery, while the second opening is utilized for the drain.

What shall be done with the bone fragments which have been removed? If they are contaminated with foreign material this should be carefully removed even to paring with the bone chisel,¹ when the fragments must be placed in a warm antiseptic solution until needed. If the surgeon fears to reimplant them in bulk, the fragments can be carefully minced up with the chisel and dusted over the membranes.

I would call attention to the peculiar value of this expedient as a preventive of the formation of a hernia cerebri, where such injuries to the dura mater exist as to forbid suturing, or where this membrane seems likely secondarily to give way. The experience of Macewen, Weir, and others incontestably proves not only the feasibility but the advantages of a resort to this procedure.

The general principles governing the treatment of compound skull-fractures are strictly applicable to gunshot wounds, so far as the bone lesions are concerned. Wharton's tables so conclusively show the ultimate evils of the retention of a foreign body in the brain, that if the operation can be done without fatal injury to the

¹ W. Macewen: October and November Nos. *Annals of Surgery*, 1887.

encephalon, balls should always be removed, since, even primarily, such injuries are certain to be followed by suppurative inflammation, which too commonly is of the diffused form, when death is inevitable.

The most superficial glance at the histories of recoveries after apparently hopeless brain injuries, shows that the result was due to free drainage, as in the famous tamping-iron case, and one of extensive shotgun disorganization of the anterior fourth of the left hemisphere, which I reported to this Society some two years ago.

The principle of free drainage then, rather than the mere removal of the foreign body, is the guiding principle of the modern treatment, although, to effect perfect drainage, both theoretically and practically, the course of the ball must be followed throughout and disinfected, when the missile being accessible, and capable years hence of producing serious trouble, should be removed.

Heretofore, the main difficulty has been a safe method of search for the ball. Fluhner¹ has, however, enunciated a new principle capable of revolutionizing practice, if found reliable, viz., the use of a peculiar probe which is allowed to pass along the track of the ball by its own *gravity*, which is so slight as to be absolutely incapable of penetrating the brain substance. The metal forming the probe is aluminum. This instrument should never be curved if it can be avoided, but when bent, the other extremity should be curved in the opposite direction; this is imperative since it is the only means of indicating what course the instrument is taking.

How, then, should we proceed in a case of ball-wound of the brain? After the usual antiseptic preliminaries and incisions, all loose bone fragments must be removed and the opening enlarged if necessary. The patient's head must be then placed so that the track of the ball is

¹ New York Med. Journal, March 28, 1885.

as nearly vertical as possible, when the probe, gently introduced into the brain-opening, is to be allowed to *gravitate* along the ball-track. Fluhner¹ has shown that when the whole cerebral mass has been traversed without penetration of the opposite wall of the cranium, the ball usually rebounds at an angle equalling that of incidence, and becomes imbedded in the brain, about one inch above, below, outward, or inward, according to the direction of the ball. If the probe shows this complete perforation to have occurred, a large counter-opening is to be made, the ball extracted, and the dressing completed as will be indicated for non-perforating ball-wounds.

Suppose, however, that the ball is imbedded in one hemisphere? Place the head as before, and locate the ball with the gravity-probe, then, if no vital parts intervene, pass the probe onward through the brain-substance till it strikes the skull; trephine at this point, cause the probe to emerge, attach two long threads of aseptic silk to the anterior extremity of the instrument, which must now be withdrawn posteriorly, leaving the threads in the wound. With the probe passed through the wound of entrance, measure the distance of the ball from the surface. Now draw through the wound track by means of one of the silk threads passed with a needle through the end and out by the eye, a No. 3 English catheter with straightened stylet, and turn the head so as to have it as nearly in a horizontal plane as possible. A pair of long, slender, double-toothed, self-closing cervix forceps, notched with a file behind the teeth so as to hold a loop of fine aseptic silk must be passed to the previously measured depth—again verified after passing the guide—alongside the catheter by means of the silk loop: if the loop does not play freely over the guide, let guide and forceps move

¹ E. M. Moore has also observed the same. Trans. Amer. Surg. Association, vol. iii. p. 91.

together. Should the ball not be found on one side of the guide, the forceps must be removed and reintroduced on the opposite side, above or below. When grasped, ball, forceps, and guide must be withdrawn together. By means of the remaining thread left in the ball-track, a drainage tube is carried through the whole course of the wound and an antiseptic dressing applied. Drainage must be effected after the same manner for perforating wounds.

Suppose the ball is not found, thorough drainage is afforded for all inflammatory products, and the chances of recovery are enhanced. In a recent case seen with Dr. Heyl at the Episcopal Hospital, failing to find the ball, I introduced a drainage tube about one inch into the brain-substance which evacuated considerable purulent fluid for one week, when it became displaced: recovery ensued without a single bad symptom, although cerebral mischief had evidently commenced before the operation, some twenty-four hours after injury.

In view of these and numerous other facts, active, but cautious interference, is not only now warranted, but demanded, for gunshot wounds of the head.

What should our attitude be with regard to that too rarely recognized condition, osteophlebitis from contusion or disease? When the "puffy tumor of Pott"¹ exists, the bone should be trephined or otherwise freely removed, the diseased area thoroughly disinfected, and strict asepsis maintained. This course, I contend, is correct, not because pus will always be found between the dura mater and bone—for this often does *not* exist—but because *osteophlebitis* is present which frequently leads to fatal septicæmia or pyæmia. That under the most unfavorable circumstances success is still attainable in cases of this nature, which have resulted even in

¹ Or other evidence of bone inflammation.

thrombosis of the lateral sinus and septic embolism of the heart and lung, is proved by a recent operation of Horsley's, the disease originating, as is usually the case, from old middle-ear disease.¹

When considering what should be done for malignant growths of the skull, two most important questions press for solution. If a patient be primarily attacked with malignant disease of the cranial bones, or the subjacent osseous tissue become secondarily involved by extension from the overlying soft parts, shall any operation be done? If an operation be decided upon, what are the prospects of relief, are they merely temporary or permanent?

If it can be shown that the necessary operative interference in such cases is not specially dangerous to life, the first question is answered in the affirmative.

As a typical instance of the successful removal of a primary growth take that of Gussenbauer,² who, for a sarcoma of the frontal bone, after reflecting one-half of the forehead as a flap, removed with chisel and forceps the frontal bone over an area measuring three by three and one-half inches, detached the growth at one point from the dura mater, and at the end of two years no recurrence was detectable.

Again, Paully³ reports the following case illustrative of the impunity with which these operations can be done. In March, 1882, he removed a portion of the frontal bone for a fibrous sarcoma. The wound healed, but at the end of two months the growth returned in situ. Curetting now failing to benefit, six months later the "frontal bone was removed from the root of the nose to the zygoma and up to the hair line; in one month the

¹ Horsley's case already referred to.

² *Zeitschrift f. Heilkunde*, Prag, 1884, Bd. v.

³ *Verhandlungen der. d. Ges. f. Chirurgie*, 1883.

wound was quite healed. Five months later an enlarged gland behind the angle of the jaw was suggestive of return."¹

Still more corroborative of the slight danger attendant upon these operations when conducted on strictly antiseptic principles, is a case of Krönlein's, which certainly teaches that in properly selected cases, malignant growths secondarily affecting the cranial vault, should be dealt with precisely upon the same general principles as govern operative treatment for similar neoplasms situated elsewhere, viz., early removal and with a free hand; if the latter part of this advice be not strictly adhered to, such operations had better not be attempted, for the danger to life is the same with no reasonable prospect of good accruing, if timidity gains the upper hand. Of course, the freedom with which surrounding parts should be removed must depend upon the importance to life or motility of the contiguous portions of the encephalon.

Krönlein, after three excisions and two free cauterizations of a carcinoma of the forehead, by another surgeon—*i. e.*, insufficient operations which were only provocative of return—successfully removed—so far as life was concerned—a cancerous ulcer, two and a half inches wide “extending from the root of the nose beyond the line of the hair.” To get well outside of the disease area, he removed a piece of bone and dura mater about three-quarters of an inch in diameter, and in addition nearly half an inch of the falx cerebri. Temporary benefit ensued, but a second operation becoming necessary two months later, the patient succumbed, but not then even until three months after this last operation.²

Although of no permanent benefit, does not such a result encourage us to demand for similar cases *early*

¹ Op. cit.

² Deutsche Zeitschrift f. Chirurg., Bd. xxi. and xxii., 1885.

complete operations? Death is inevitable sooner or later, and is it not worth while to run the comparatively small risk inherent to such operations, to achieve occasionally a permanent result?

Of fifteen cases done with full antiseptic precautions thirteen recovered from the operation and two died—one of air embolism, a preventable accident.¹ The dura mater was incised or portions excised in eight cases; in four operations the falx cerebri was cut; the longitudinal sinus was twice divided; and in as many instances portions of brain substance were removed. In all considerable bone was excised, and in five the gap left measured transversely three inches. These fifteen operations were done upon twelve patients, in all but two the growth occupying the frontal region. Recurrence took place in only one instance before healing and rapid recidives, all told, in four cases.² Such a showing, I believe, warrants the following statement.

That when malignant, or other tumors clinically dangerous to life, attack the accessible bones forming the brain-case, early and thorough removal is indicated, provided the proper completion of the operation does not necessitate the removal of portions of the encephalon essential to life or, perhaps, to progression.

A much larger measure of success awaits those who now operate for that very fatal complication, intracranial hemorrhage, than formerly obtained. The statement of Hutchinson³ is no longer true, that "the modern annals of surgery do not contain any cases in which life has been saved by trephining for this state of things."

¹ Either by previous ligation of an endangered sinus or keeping the head low and irrigating the wound constantly.

² Editorial, THE MEDICAL NEWS, Dec. 5, 1885, pp. 629-630.

³ Several of these successes had occurred within a few years of the time Hutchinson wrote, and this statement is merely an evidence of careless research.

Cecherelli,¹ Krönlein, Weiseman, and others have presented an overwhelming mass of statistical and practical evidence of the advantages of operative interference.²

The first question to be settled is, Shall an anæsthetic be given? After Godlee's experience, I for one, think that chloroform is certainly contraindicated, while I also believe that ether is prejudicial and is usually unnecessary from the semi- or completely comatose condition of these cases.

Again, where should the skull be perforated in those cases where neither fracture nor external injury exists.

Since the middle meningeal artery is usually the source of hemorrhage, unless specially contraindicated, the trephine had better be placed³ from an $\frac{5}{8}$ inch and a quarter to an inch and a half behind the external angular process of the frontal bone on a horizontal line drawn around the skull, at the level of the upper margin of the orbit, parallel with "Reid's base line." Should this opening reveal neither clot nor a bleeding vessel, a second opening on the same line just below the parietal boss must be made.⁴

In one successful case of Krönlein's these two openings were made and a drainage tube passed through both.

The same surgeon correctly diagnosed the pres-

¹ La trepanazione del cranio in rapporto alle sue indicazioni, *Annali univers. di med. e. Chir.*, April-June, 1885.

² A high temperature suddenly induced after a head injury, with slow pulse, slow labored respiration, slowly increasing hebetude and hemiplegia, after an interval of consciousness following the traumatism have lately been asserted to be conclusive proof of intracranial hemorrhage from the middle meningeal artery.

³ Krönlein: *Deutsche Zeitschrift f Chir.*, Bd., xxiii., Hefte 3 und 4, 1886.

⁴ Where a vertical line carried directly upward behind the mastoid process bisects the horizontal line.

ence of clot in four cases, in two successfully operating and removing it, but failing to make the second opening in the other two, the patients died, post-mortem examination showing that a second perforation would have been successful.

Wetherle¹ also reports a fatal case owing to failure to make this second opening. After removal of the clot by forceps and antiseptic irrigation, unless all bleeding has ceased, if in the dura mater the vessels must be secured by ligatures passed with a curved needle, by a red-hot knitting needle, or acupressure will suffice;² or, again, especially for the vessels of the pia mater, *serre-fines* left until spontaneously separated may be tried.³

I, in common with others, have been compelled to resort to antiseptic tampons. Unless through-drainage is clearly necessary, the first bone-button had better be replaced when two openings have been made, and the more dependent one utilized for drainage. If after trephining severe secondary hemorrhage occurs, Jacobson recommends first the application of a freezing mixture over the dressings, then placing the patient in the upright posture, next compression of the common carotid, and finally, if this fails, ligation of the same vessel.

Weiseman's latest statistics⁴ show that of 147 cases treated by the expectant plan 131 died, or about nine-tenths, while of 110 operated upon, only 36 died, or about one-third. Moreover, it must be borne in mind that in

¹ Northwestern Lancet, Nov. 15, 1885.

² A pellet of wax, or plugging the canal, when it exists, with a match are other means.

³ This was suggested by Fluhrer, *op. cit.*

⁴ Ueber die Indicationen zur Trepanationen mit besonderer Berücksichtigung, etc., Deutsche Zeitschrift f. Chirurg., Bd. xxi. und xxii., 1885. I would here acknowledge my indebtedness for the facts from these papers to leading articles in THE MEDICAL NEWS of December 26, 1885, and May 8, 1886.

the majority of those who died, the extravasation was not reached, and, of course, not removed; had this been done the mortality would, undoubtedly, have been less.

This is a far better showing than my statistics collated in 1883, and is unquestionably due to the prevalence of antiseptic methods. Indeed, Krönlein maintains that this operation, aseptically performed, is perfectly safe, death resulting simply from complications unconnected with the operation.

The chief advance in the treatment of brain abscess is the making of a second bone opening at the most dependent portion of the cavity, if the first trephine cut is not favorably situated for drainage, after which the first opening can be closed by its own bone-button, notched on one side to prevent accumulation of pus and wound-secretions. Mr. Barker prefers a silver to a rubber tube, as being both easier of introduction and retention. Fenger and Lee's¹ case teaches how gradually the tube must be shortened, and how long after its final removal it is wise to watch a case. Both upon anatomical and pathological grounds, I think that it is usually best to trephine for intracranial suppuration following chronic ear disease, one and one-fourth inches above, and the same distance behind the centre of the cartilaginous external auditory meatus. Through the perforation thus made the pus must be sought by passing an aspirator needle downward, inward, and slightly forward, toward the petrous bone. When the pus is found, the needle track can be enlarged by a Volkmann's spoon,² and a drainage tube introduced.³ The point mentioned has been selected because pus is

¹ Transactions American Surg. Association, vol. iii. pp. 65, et. seq.

² If preferred, a pair of dressing forceps can be first carried down along the needle as a guide, and withdrawn, after Hilton's method, but the spoon seems better.

³ Barker: Macewen, Schomdorff, Trunkenbord, Greenfield report cases; all recovered.

more often found in these cases in the temporo-sphenoidal lobe than in the cerebellum or elsewhere, for the tympanic roof is the thinnest portion of the bone, while more vessels pass from the tympanum and along the squamoso-petrosal suture to the dura mater than from the posterior portion of the petrous bone. In all cases, however, the foramen for the mastoid vein should be examined, before perforating the bone, because "if there be inflammation on the posterior aspect of the petrous bone, it can hardly reach the cerebellum without forming a layer of pus under the dura mater of the lateral sinus. If this is so the pus will escape by the mastoid foramen if the latter be exposed."¹ When this condition is found, a spot beneath and slightly posterior to the mastoid foramen, below the inferior curved line of the occipital bone, will be the proper place to explore for cerebellar abscess following chronic middle ear trouble.² I have given Mr. Barker's points for perforation in preference to those of Mr. Caird and others, because they are safer anatomically, since they are less apt to injure the meningeal artery, the pus can be evacuated through a comparatively callous portion of the brain, and nine-tenths of these abscesses in the temporo-sphenoidal lobe occupy a space three-fourths of an inch in diameter, whose centre is one and a half inches above and behind the centre of the cartilaginous external auditory meatus.³

In this connection let me give the result of Spitzka's researches as to the use of exploratory aspiration. "Experience with human and experimental pathology teaches that exploratory needles should never be introduced into the internal capsule, the contiguous ganglia or the lateral

¹ Barker: Brit. Med. Journal, December 11, 1886, p 1155.

² Op. cit. Cerebral abscess is three times as frequent as cerebellar or those in other portions of the encephalon.

³ Barker: Brit. Med. Journal, 1887, vol. i, p. 407.

ventricles, merely for exploratory purposes, unaided by positive clinical evidence of the location of the disease; but no hesitation need be felt in the puncturing of the brain for hydrocephalus."

"Accessible neoplasms of the brain, which have resisted medicinal treatment, and which continue to grow and threaten life, should be removed, for the reason that they are generally single, seldom have secondary deposits, are surrounded by an inflammatory zone of demarcation, and *always* kill by pressure."¹ These words of Amidon's admirably express the present position of surgery with regard to brain tumors. But can every case which resists medicinal treatment be confidently turned over to the surgeon with the idea that whether the case recovers or not, at least the tumor can be found, and the operation can be completed.

W. Hale White's² analysis of 100 brain tumors examined after death, shows how rarely such operations are feasible. Thus:

Of 45 tubercular tumors, 7 possibly could, and 3 certainly could have been removed.

Of 24 gliomata, perhaps 6, and certainly 4 might have been operated on.

2 glio-sarcoma would have been inoperable.

Of 10 sarcomata, only 1 could have been removed.

Of 5 carcinomata none ought to have been attacked, because of secondary growths or multiplicity of tumors.

5 gummata could all have been reached, but would have been, of course, amenable to medicinal treatment.

Of 4 cysts 1 could have been reached.

Of 3 tumors whose nature was doubtful, 2 would have been fit for the knife.

1 lymphoma from general contamination would have been inoperable; and finally,

¹ Op. cit.

² Guy's Hospital Reports, vol. xliii, 1886.

1 myxoma would have been accessible.

Closely scrutinized, of this 100 cases only 12 were certainly operable, and 6 more could possibly have been successfully attacked.¹

While unable to give statistics of completed operations or brain tumors, when we recall Horsley's remarkable series, Durante's and Keen's successes, is it at all doubtful that the mortality will greatly diminish in the near future? A rapid review of Horsley's methods will show why his success exceeds that of others.

The head must be carefully shaved the day before operation, washed thoroughly with soft soap, followed by ether, the situation of the growth localized and marked on the scalp, the head covered with lint wet with 1 : 20 carbolic lotion, and oil silk with a layer of cotton bandaged over all. A purgative should be exhibited the night previous to, with an enema on, the morning of operation.

About one hour previous to the administration of the anæsthetic a hypodermatic injection of one-quarter of a grain of morphia should be given, and, unless the heart be diseased, chloroform is preferable to ether, since ether produces more cerebral excitement. The object of administering morphia is twofold—*i. e.*, less chloroform is needed, and from Schäfer and Horsley's experiments, this drug contracts the arterioles of the central nervous system,² thus lessening hemorrhage.

The chief risk being septic encephalitis, the spray may be used solely as a cleanser of the atmosphere.

All incisions of the soft parts should be vertical to the skull, and include all the layers at one stroke, except the

¹ The figures differ from those given by the author, but careful addition of the numbers given in the text sum up as I have given above.

² When tapping for hydrocephalus I have resorted to this method with apparent benefit.

periosteum. A single flap should be thus raised, its outline being a shallow curve, in order not to divide collateral vessels, and so planned as to avoid the main scalp arteries. These indications can readily be fulfilled without interference with drainage, since the patient will lie in the supine position.

The periosteum must now be incised, raised, and reflected; if more bone has to be removed than was originally planned the periosteum must be carefully dissected back off each new portion.

Two large trephine cuts—Horsley recommends that the crown of the instrument be of the diameter of two inches—should be made at the two extremes of the bone area to be removed, when the intervening bridge can be partially sawn through with a Heys saw, and the division completed with the bone forceps. Almost as rapid, and a far safer plan—since the bone over brain-tumors is often not thicker than cardboard—is to remove the bone with the rongeur, as modified by W. Barton Hopkins, after one or more preliminary trephine cuts of the ordinary size. In many instances the bone fragments had better be replaced, and accordingly should at once be placed and kept in a warm antiseptic solution.

Next the dura mater must be cut around four-fifths of the osseous orifice, one-eighth of an inch from the bone, so as to leave room for stitching; start the incision with a scalpel, but complete it with blunt-pointed scissors. Any arteries seen lying in the line of the proposed dural incision must be first tied, by passing ligatures through the dura, beneath and around the vessels, with a curved needle before incising the membrane.

The brain being now exposed, note first if it bulges into the wound—*i. e.*, is the intracranial tension increased? Next look for a yellowish tinge or possibly lividity, which will denote a tumor in the corona radiata beneath the

cortex. Now closely scrutinize the vessels and perivascular lymphatics, noting especially "any yellowish-white patches in the walls of the latter indicating old mischief." Finally ascertain whether the brain has undergone any alterations in density, although in most subcortical tumors the diagnosis can only be made certain by an exploratory incision.

Hemorrhage has been much dreaded in the removal of brain tumors, but the fear is unfounded, for the arteries and especially the arterioles, which are chiefly concerned in such operations, run perpendicular to the cerebral surface and sponge-pressure soon checks all bleeding. Should this fail, ligature of the larger vessels must be tried, but if their walls are too fragile¹ to stand ligation, forcipressure is alone available. In one case at least, Weir's,² continuous pressure with iodoform-gauze packing failed to prevent fatal secondary, or rather recurrent hemorrhage, and the operator declared that should a similar case occur in his practice he would leave one or more pressure-forceps on the bleeding vessels for from twenty-four to forty-eight hours. Fluhrer³ has shown that the ligature often fails to hold on the vessels of the pia mater, and advises leaving Nunneley's artery-forceps on any bleeding points until the instruments separate of themselves. I recognized the advantage of this practice recently, when assisting Dr. Simes in a case of subdural hemorrhage proceeding from a wounded artery of the pia mater; here a small wire serre-fine was substituted for the pressure-forceps, and left *in situ* for days. As the cerebral arteries are terminal, avoid every vessel possible,

¹ Dr. W. W. Keen informs me he met with this difficulty, and succeeded by drawing the catgut only tight enough nearly to close the lumen of the vessels.

² Birdsall and Weir: *Annals of Surgery*, August, 1887, p. 149.

³ *Op. cit.*

this end being often attainable by lifting them out of the sulci between the convolutions, and after removing the subjacent brain, replacing the pia mater. Horsley thinks that if any thrombosis should occur in these vessels it would only be temporary. If one of the large venous sinuses be wounded during an operation, its ligation is a perfectly safe procedure, healing occurring as in veins, and collateral vessels enlarging alongside of the occluded channel. Sponge-implantation or antiseptic tampons will always temporarily and often permanently¹ arrest the bleeding from a wounded sinus. The risk of air embolism is not imaginary, but can be obviated by keeping the head low and the wound well irrigated. When it is evident that a sinus must be wounded in a proposed operation it had better be primarily ligated as in a case of Küster's.²

Incisions into the brain must always be clean-cut, be vertical to the surface, and directed into the corona radiata, when necessary, so as to avoid damage to the fibres coming from other portions of the cortex, or those surrounding the seat of operation. The paths pursued by the fibres from the cortex must be kept constantly in mind when incising the brain, and where possible portions of each centre involved should be left, as under such circumstances the coarser movements of the part governed will often be retained.³ Finally, it is absolutely essential to be thoroughly familiar with the encephalic blood supply to decide where to make the incisions, in

¹ Author's article, *International Encyclopædia of Surgery*, on "Head Injuries;" also Hopkins, *Annals of Surgery*, July, 1885, p. 65.

² See Senn on "Air-embolism," or *Berliner klin. Wochenschrift*, p. 673, 1881.

³ See H. Jackson in discussion on Horsley's paper "Brain Surgery," *British Med. Journal*, 1886, vol. ii. pp. 670-675.

order to have a full understanding as to what portions of the remainder of the organs certainly will be deprived of their blood supply, and what portions may possibly be rendered avascular.

When a portion of brain is excised, the underlying cerebral tissue soon bulges up almost to a level with the cortex while the cut edges evert, and if "less brain than bone is removed," protrusion—*i. e.*, an acute hernia cerebri forms. A persistence of this dangerous condition is prevented by the weight and primary union of the scalp-flap; the advantages afforded by the large one recommended are thus apparent.

After all oozing has been arrested by gentle sponge-pressure or ligatures, in my judgment the flap of dura mater, if the operative procedures have left it intact, should now be carefully sutured with chromic catgut to the margins of the membranous opening, leaving space for the easy passage of a drainage tube at the most dependent point. The scalp-flap should then be laid down and secured by stitches of medium silk placed one centimetre (about one-third of an inch) apart with horsehair sutures between.

When brain substance has been removed drainage should not be kept up more than twenty-four hours, because firm union must be secured within four or five days, and a certain degree of pressure should in the meantime be exercised upon the brain which tends to protrude, in order to avoid hernia of the organ. Again, there should be some protective between the brain and scalp in the form of soft—*i. e.*, non-inflammatory—connective tissue. Briefly, all these desirable results are obtained by:

1. Placing a tube at the most dependent portion of the wound when the patient lies supine, for twenty-four hours only, to drain all blood and serum.
2. After twenty-four hours remove the tube and re-dress

as at first antiseptically, making "firm but gentle pressure over the centre of the flap."

3. If on the third day pain and throbbing in the wound be complained of, and the flap, on exposing the wound, be found "distended in the centre the periphery being firmly united," undue collection of wound-fluids has taken place. If it appears probable that the pressure will break down the union of the flap, the track of the drainage tube must be gently opened up with a probe, and some of the pent up fluid let out; if the union seems safe to hold, let the accumulation alone, since after the evacuation of the fluid the advantages of supporting pressure are lost. The tension at most usually requires to be relieved but once. This liquid cushion, until absorbed, represses the tendency to hernia, promotes absorption by the meningeal lymphatics of all inflammatory exudates, thus favoring rapid union, and serves as a scaffolding for the formation of normal connective tissue which is formed within a few days, at least in the lower animals.

After from five to seven days boric acid, cotton, and collodion for support are better than the ordinary antiseptic dressing. The stitches can be removed any time after the first week.

Should a second operation become necessary, or a primary one for brain injuries which have resulted in scars of the cortex, especially those produced by traumatic losses of brain-substance, which have healed after free suppuration, great caution must be exercised, since the cicatrices often displace large vessels, and are traversed by veins of considerable size.

Encouraged by Horsley's success in excising brain-scars for epilepsy, Hughlings Jackson¹ has suggested the propriety of removing the seat of "the discharging lesion," in cases of the spontaneous variety, when the

spasms begin "very locally, deliberately, and when the fits are often repeated."

The theoretical advantages of this suggestion have been essentially proved by the following case of Macewen's, which certainly seemed cured by the removal of the site of the discharging lesion,² as well as by one of Jackson's, operated on by Horsley.

A young man in perfect health, having received two years previously a skull injury, which in six weeks resulted in headache and epilepsy, came under Macewen's care, suffering from one hundred or more attacks per diem; in which, however, he never entirely lost consciousness. The muscular spasms were limited to the side opposite that of injury, at which point a slight depression was detected. Trephining here at once uncovered the brain, revealing an old rupture of the membranes. A small circumscribed area of non-suppurative inflammatory softening existed beneath the bone-opening. Although apparently thoroughly anæsthetized, the removal of the diseased tissue with a sharp spoon at once produced a violent convulsion. All pain and convulsions ceased after the operation.

In traumatic epilepsy, then, in addition to the removal of all depressed bone, cicatrices of the brain and membranes must be freely excised, including, if possible, the site of the discharging lesion.

Cysts should, after the same precautions as advised for cerebral tumors, be carefully curetted and drained, preferably by the tube, but recognizing the risk of *hernia cerebri* by this method of treatment.

For the successful therapeutics of *hernia cerebri*, it is requisite to place absolute confidence in the indications for treatment so plainly discernible after a careful study

¹ British Medical Journal, October 9, 1886.

² Senn's Four Months among the Surgeons of Europe, p. 17.

of the pathology of this affection. There are two principal and one subsidiary factors in the production of hernia cerebri. As has been said, the normal intracranial tension after incision of the membranes and removal of a portion of brain, suffices to cause cerebral protrusion, if less brain tissue than bone is removed. Hence, the removal of the support of the membranes and bone, plus increased tension are the chief causes, and, in consequence, anything favoring these conditions is to be avoided. What can increase intracranial tension? Manifestly only encephalitis, which is also productive of the subsidiary, but effective factor, softening of the cerebral tissues. How can we best prevent intracranial inflammation? By strict asepsis. But is this all that is essential? No; for the normal intracranial tension, as we have just seen, is almost efficient by itself, so that suturing of the damaged membranes must be done when possible. Where the suturing either cannot be done, or seems likely to fail, Horsley's modified drainage, to keep up due restraining pressure should be tried. Finally, I would make a tentative suggestion, grounded upon the treatment of a somewhat similar condition of the membranes of the spinal cord, viz., the suturing to the margins of the membranous defect, a thin slice of aseptic sponge; in other words, a sponge graft, which may serve, after infiltration with and organization of the contained white cells, as an effectual barrier against brain protrusion. Moreover, whenever possible, replacement of the bone fragments, either in toto, or after Macewen's plan, will in many cases afford the requisite amount of restraining pressure.

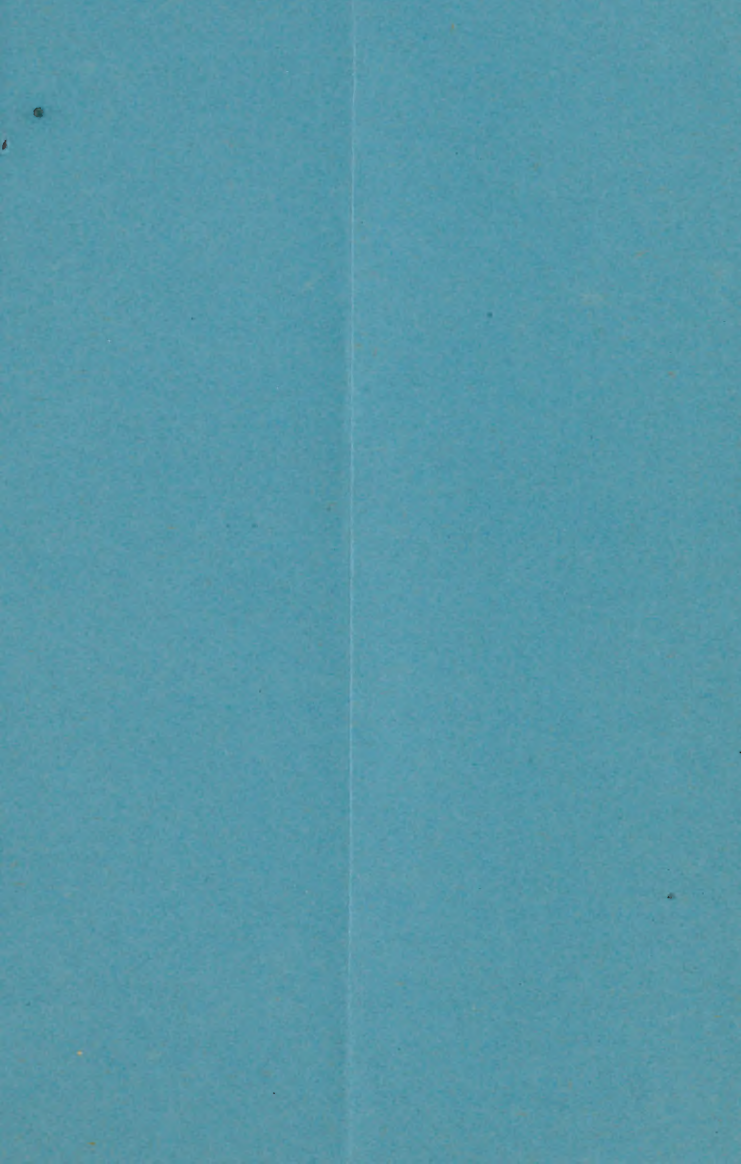
I would here call your attention to the steadily lessening mortality attendant upon the strict aseptic treatment, aided by gentle pressure, of hernia cerebri, and the avoidance of anything which will weaken the support of the layer of granulations, which forms, or tends to form,

over the exterior of all brain protrusions, which is the sole barrier against further extrusion of the cranial contents, and which by its organization into contracting scar-tissue finally reduces the hernia.

The experience of the last four years has proven the truth of what I advanced years ago, that ligating, excising, and cauterizing these protrusions, while at times ending in recovery, is unscientific, because opposed to the indications derived from the pathology of the affection ; and that such practices are attended by a rate of mortality far higher than that just advocated. The danger does not reside in the mere protrusion of brain-substance, but in the *encephalitis* which is the cause of the hernia, or is consequent upon it.

In conclusion, let me venture the prophecy, that those of my hearers who now consider much of what I have advanced to-night as far too heroic, will live to look upon my suggestions as mere matters of course, and as little to be reprobated as ovariectomy.

NOTE.—I would here acknowledge my indebtedness to my friend Dr. A. B. Hirsh, for his translation of Seydel's work quoted in the text.



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